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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

HENRY S. GRAVES, FORESTER

INSTRUCTIONS FOR MAKING TIMBER SURVEYS IN THE NATIONAL FORESTS

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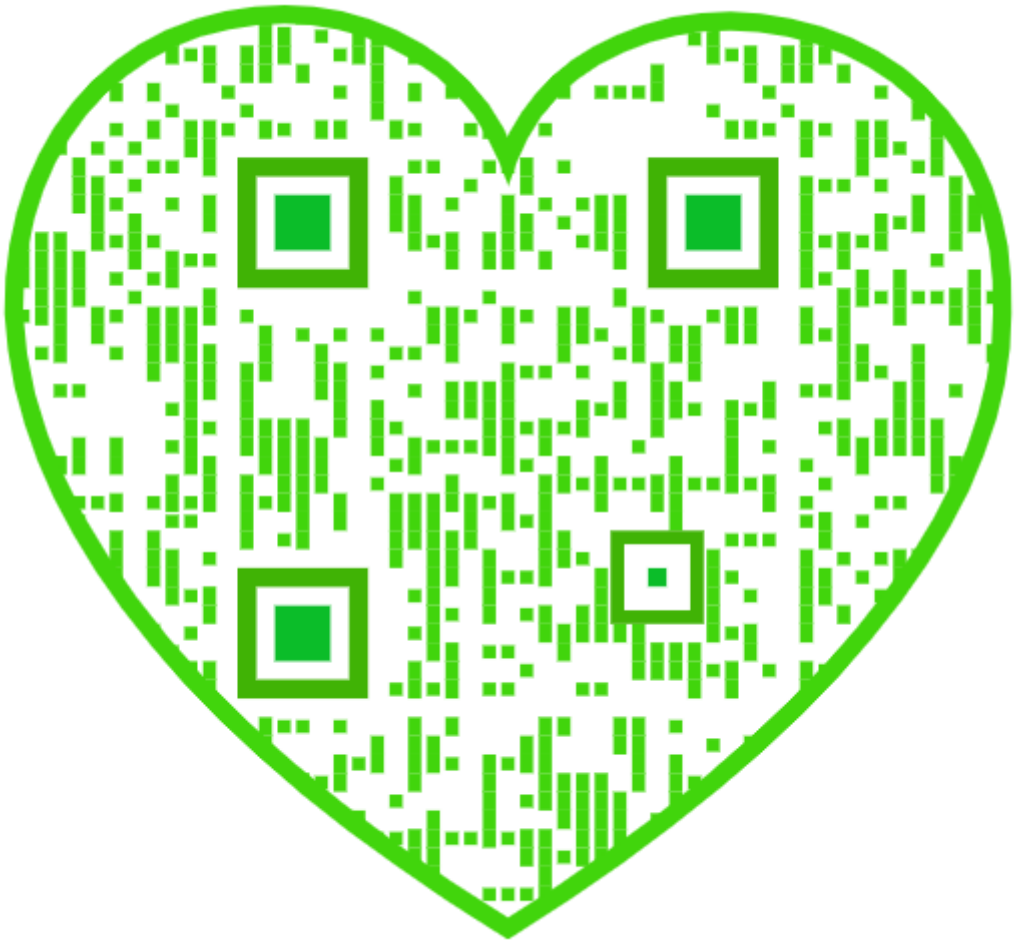

Class
Book

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE.
HENRY S. GRAVES, Forester.

INSTRUCTIONS
FOR
MAKING TIMBER SURVEYS IN THE NATIONAL FORESTS

INCLUDING STANDARD CLASSIFICATION
OF FOREST TYPES.

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INSTRUCTIONS FOR MAKING TIMBER SURVEYS IN THE NATIONAL FORESTS.

PURPOSE OF HANDBOOK.

The purpose of this handbook is to present the policy of the Service for the conduct of timber surveys and to standardize the methods used in the districts to the extent necessary to insure reasonably accurate and uniform results. Conditions in the districts differ to such a degree that in some respects standardization of methods is not felt to be desirable. It will be necessary, therefore, for each district to issue supplemental instructions to its field officers, based upon the principles herein outlined regarding methods not standardized by this handbook.

PRINCIPLES GOVERNING TIMBER SURVEYS.

OBJECT.

The immediate object of timber surveys is primarily to secure data needed in connection with timber sales. It is the policy of the Service to have a thorough examination made of prospective timber-sale areas as a basis for determining whether a sale is silviculturally desirable, for the timber appraisal, and to supply data essential to the preparation of a plan for marking, conditions of contract, and sale administration. Since the data secured constitute an inventory of the timber resources on the tract, and the preparation of a topographic map is a requisite to the project, timber surveys, besides furnishing information needed in timber-sale work, also give data needed in the preparation of plans for fire protection and forest improvements. Since timber surveys are essential to intensive forest management, they will be extended as rapidly as funds not

required to meet the more immediate administrative needs are available. As rapidly as areas are covered by timber surveys the data supplied will be made a part of the Forest plan.

A stumpage appraisal is not necessarily a part of the timber survey, since an appraisal may not always be desirable in connection with a particular project. Sufficient data should be secured, however, on the character of the timber and topography of the area to make it unnecessary for the appraiser to concern himself with other than the layout of the prospective operation, the methods and investment required for the exploitation of the timber, and such special points as checking the quality of the timber as given by the timber-survey crews. The appraiser should be able to secure all other data needed, as they relate to the timber and area, from the timber-survey reports. The test, then, of a satisfactory timber survey is the completeness with which it presents the data other than those connected with logging methods and costs needed by officers conducting appraisals.

CLASSIFICATION.

The Service recognizes two classes of timber surveys—extensive and intensive. By the former is meant a rough determination of the amount and condition of the timber on a given area and the preparation of a sketch map of no stated requirements as to accuracy. Any project which fails to meet the requirements prescribed herein for estimating (see "Estimating") and for map standards 1, 2, or 3, as prescribed by the Instructions for Making Topographic Surveys and Maps, will be considered an extensive project. The circumstances which make extensive projects necessary are such as to preclude a standardization of method, and no attempt is made in this handbook to cover methods solely applicable to them. Each district is authorized to require the use of the methods of conducting extensive timber surveys which have been found most satisfactory.

Intensive timber-survey projects are those which conform with the estimating standards herein given and to mapping standards

1, 2, or 3 of the Instructions for Making Topographic Surveys and Maps. It is with this class of timber surveys that this handbook deals.

POLICY.

Up to and including the fiscal year 1916, 47,291,660 acres have been covered by extensive timber surveys, and 20,815,798 acres by intensive methods. It is estimated that there remain approximately 90,000,000 acres of National Forest lands bearing timber of commercial importance to be covered by surveys before complete data essential to Forest plans is secured. The completion of 1,000,000 acres per year as a minimum, with the present appropriation, is the basis of the timber-survey policy.

In addition to the timber surveys made as an incident to small sales, local forest officers occasionally have an opportunity to secure similar data at odd times when administrative demands are not pressing. Timber surveys in spare time should be encouraged to the fullest extent. It is advisable, however, for the sake of maintaining satisfactory standards, to have these individual efforts directed by instructions prepared by the district forester or forest supervisor. Similarly, crews comprised of local officers should be assembled for timber surveys, when time or funds are available for the purpose; but in this case also the work should be well directed and controlled. In the conduct of many projects it will be necessary to organize special crews.

The relative importance and the basis for the selection of projects are as follows:

(1) Areas containing timber which should be cut and for which bona fide applications for purchase have been received.

(2) Areas within which desirable sales can undoubtedly be made in the near future if estimates and other essential data are available.

(3) Forests or portions of forests in which there is danger of overcutting, either in large or small sales:

(*a*) In excess of the amounts which should be reserved for local needs or to guarantee a reasonable operating life for improvements constructed in connection with current sales.

(*b*) In excess of sustained yield.

Timber surveys on areas proposed for exchange with States or private owners will be undertaken only when specifically authorized by the Forester.

FUNDS.

Special funds are provided for the conduct of timber surveys, from which allotments are made to the districts. These funds should be supplemented as far as "contributed time" can be made available for the accomplishment of all needed projects in the order of importance outlined above.

PRELIMINARY EXAMINATION.

A preliminary field examination will be made of all projects requiring the approval of the district forester or the Forester, unless the essential data have been obtained previously. The object of such an examination is primarily to determine the need and urgency of the project, in accordance with the policy previously outlined, taking into account available funds and the practicability and desirability of a sale from silvicultural and other standpoints. Incidental to these objects is the securing of data which will be of value in organizing the work and conducting the project efficiently. In order that the essential features may be competently passed upon, the examination should be made by the chief of party, forest supervisor, or a qualified member of the Forest force, and a logging engineer or other representative of the district office familiar with timber survey, timber sale, and silvicultural practice, and with appraisal methods and requirements. It is preferable to defer a project an entire season, pending a preliminary examination, rather than to launch it without definite assurance that the expenditure is justified by the project's expediency and importance. Upon the completion of the examination the examiners will notify the district forester of their conclusions on the advisability of undertaking the project. If the district forester believes the project advisable, the examiners will prepare a project plan.

PROJECT PLAN.

The examination should be sufficiently intensive to permit of the preparation of a plan for the project, if approved, which will cover:

(1) The area which should be covered by the timber survey, specifying the approximate limits of merchantable timber as a basis for adjusting the intensity of the cruise in merchantable and unmerchantable timber areas. (See "Estimating.")

(2) A detailed plan for control, topography, and estimate, reference being made to existing instructions in the Instructions for Making Topographic Surveys and Maps and in this handbook.

If not covered by outstanding district instructions, there should be included in the plan a clear explanation of the methods of classifying and treating, with reference to the particular project, the subjects listed on Form 494, i. e.:

Height class.
Site.
Forest type.
Age class.
Condition of timber.
Quality of timber.
Logging factors.
Reproduction.
Notes.

Detailed instructions also should be included on the application of volume tables; on the methods of recording estimates of timber of merchantable size, by species, whether commercially important or not, by diameter breasthigh, and top diameter inside bark, and recording trees below merchantable size to a minimum of 6 inches diameter breasthigh.

(3) The availability of existing maps and survey field notes for the area and the extent to which these data can be used.

(4) The size and organization of the party.

(5) Necessary equipment, transportation facilities, trail construction required, possible camp sites, etc.

The engineering and mapping features of the plan will be referred to the office or individual in the district office best qualified to pass upon them before approval by the district forester. The approved plan will constitute the basis for the

conduct of the project and will remain in effect until the project is completed, unless modified by the district forester or with his permission.

APPROVAL OF PROJECTS.

All projects involving the expenditure of funds from the special timber-survey schedule will be approved by the Forester. A transfer of funds between approved projects is permissible without reference to the Forester. Projects will be submitted to the Forester for approval, with the annual report called for under "Administrative reports," for consideration by him prior to the submission of detailed allotment estimates by the districts. If a change in the district's plan for timber surveys, as approved by the Forester, arises later, involving a project not previously acted upon, the district should immediately notify the Forester. Unless already prepared it will not be necessary to submit project plans to the Forester at the time approval of the project is sought. The responsibility for the completeness of project plans rests with the district forester. Copies of all plans for Forester's projects actually undertaken should, however, be submitted for the information of the Forester as soon as practicable. So that there may be no delay in field work during the most favorable season, preliminary examinations should be conducted and plans prepared well in advance of the time contemplated for field work.

The district forester will exercise such control over the conduct of timber-survey projects involving other than special funds as he may deem desirable to secure satisfactory results. It is expected that the instructions issued by the districts in regard to timber-survey work will include the procedure to be followed on both large and small projects, together with such specific instructions applicable to the particular project as may be necessary.

ORGANIZATION.

To the extent found practicable with the funds available from the special schedule and by the use of contributed time,

each district should develop an organization for the conduct of timber surveys. It is realized that until a definite sum can be allotted annually to each district, considerable difficulty will be experienced in maintaining a stable timber-survey organization. Projects, however, should not for this reason, or because of lack of special funds, be deferred when it is practicable to organize crews of less experienced men whose services in the form of contributed time are available.

It is intended that the special schedule shall provide for the more urgent projects which will permit the early consummation of a sale. Although not restricted to this use, it is considered primarily a sale-development fund. Provision for sale administration should be made from the general-expense funds. The special schedule should be used for sale administration only with the Forester's approval, when a lack of other funds makes this course unavoidable.

It is essential that the nucleus of the crew consist of men of tried experience on timber surveys. There should be enough trained men in field parties to obtain the technical data required and to insure a corps of experienced men to take charge of parties in the future. As a general rule, at least 50 per cent of each field party and of each working crew should be men of previous experience in Forest Service timber surveys, and preferably also in scaling, timber-sale administration, and mapping. As a means of increasing the efficiency, men selected for timber surveys should, when practicable, receive assignments to timber sales when not engaged upon survey projects.

Frequently it may be necessary to employ men temporarily to supplement permanent employees in timber-survey crews. Such men, unless clearly qualified for assignments involving greater responsibility than is customarily put upon them, should be appointed field assistants under the conditions and subject to the minimum and maximum salary standards established by the Service for this class of employees.

In the larger projects it is particularly important that there be assigned to the crew one or more men skilled in survey and

topographic work who can assist and advise the chief of party in attaining the accuracy in control and topography established by the Instructions for Making Topographic Surveys and Maps. Similarly, in such projects, provision should be made for the inclusion in the party, if this work can not be done by the topographer, of a man skilled in drafting, to whom will be assigned the responsibility, under the chief of party, of compiling the map data collected by the crews and of keeping the camp map up to date.

RESPONSIBILITIES.

District Office.

Besides preparing a plan for the conduct of the project, the district office will see to it that the party gets the work under way in a satisfactory manner. A representative of the district office should visit each party, preferably with the supervisor, when the field work begins, or as soon thereafter as practicable, to see that the work is conducted along the lines outlined by the plan and that the methods prescribed are thoroughly understood. If any changes in the plan seem to him desirable he should report them to the district forester, or, in case previous authority has been given him by the district forester, put the changes into effect immediately. The district office will also conduct such additional inspections of the work of the crews as may be found necessary to conform with the instructions under "Field checks and inspection."

Forest Supervisor.

There should be a clear understanding between the district office, the supervisor's office, and the chief of party concerning the relation of the project organization to the Forest organization. The forest supervisor will be expected to render to the timber-survey party every assistance practicable. In its turn, the timber-survey organization will be expected to assist the supervisor to the fullest extent possible in meeting any serious fire hazard. The extent to which cooperation between the supervisor and the survey crew can be carried is for the district

forester to determine in each case. Unless expediency requires another course, the timber-survey organization should be placed under the direction and supervision of the forest supervisor, who should be held responsible for the efficient execution of the project. He should be made to feel a direct and personal responsibility for the manner in which it is conducted, as well as for the accuracy of the data secured and manner of its presentation.

Chief of Party.

Direct responsibility for the conduct of the work on the ground will rest with the chief of party, who should be selected, subject to the approval of the district forester, for his experience in timber surveys and general National Forest work, and his ability to handle the crew. The chief of party will be expected to see that the project plan is thoroughly understood and followed by the men, to maintain discipline, to exercise ample checks, to arrange for the assembling and correlating of data so that they can, if necessary, be turned over to a successor. He should also become sufficiently familiar with the conditions on the area, as a whole, to be able to prepare at the completion of the project a comprehensive report. The chief of party will be subordinate to the forest supervisor, unless the matter is arranged otherwise by the district forester.

Aside from general supervisory duties, which must necessarily take precedence over other work, the relative importance of the duties of the chief of party is as follows:

(1) Periodic instruction of strip crews in their duties and checking their performance.

(2) Check estimates.

(3) Current compilation of map data in building up project maps.

(4) Assembling data for stumpage appraisal.

Members of Party.

The topographer or draftsman, as the case may be, will assist the chief of party in conducting and supervising the

control and topographic work done in connection with the project, and will, if best qualified to do so, instruct the men in the details of topographic methods and in preparing their field sketches for use in the compilation of the camp map.

Arragements should be made to have a member of the crew who can best be spared for the purpose relieve the chief of party of as much camp routine as possible, such as ordering and checking property, supplies, etc. In parties of 10 men or more, it may be found necessary to have an assistant chief of party to take over work of this character, leaving the chief of party free for the required amount of supervision and such original work on his part as may be necessary.

If not included in the general district instructions, the plan for the specific project should give in as much detail as practicable:

(1) The duties of the members of the party by classes.

(2) What data each class is to collect.

(3) The object of these data.

By every possible means the whole timber-survey force should receive an insight into the broader phases of the work and its ultimate results. This is of the utmost importance in arousing a personal interest in the work, which is essential to a high degree of accuracy and efficiency.

FIELD METHODS.

SURVEYS.

The Topographic Surveys Manual outlines the Forest Service standards of mapping and the methods for securing the degree of accuracy required under each standard. Standards are fixed for primary control, secondary control, and interior lines. The aim of these standards is to secure maps of sufficient reliability to be accepted as a part of the permanent Service map record. The degree of accuracy attained under them will permit the use of the maps for all administrative needs.

As far as practicable with the funds available, all surveys and maps made in connection with timber-survey projects will

conform to one or a suitable combination of the standards outlined in the Instructions for Making Topographic Surveys and Maps. Standards 2 and 3 of the above Instructions, or a suitable combination of those standards, will be used for surveying and mapping on intensive timber-survey projects. The use of standard 1 survey and map methods solely for timber-survey purposes will be permitted only with the approval of the Forester. The Forester's approval must also be secured for the use of funds from the special schedule for the extension beyond the limits of the project of control lines or stations which are not essential to the surveying and mapping of it under the standard selected.

The selection of methods from those outlined for the standard is discretionary with the district forester. Where a combination of methods prescribed for secondary control and interior lines under standards 2 and 3 is used the principle of consistent accuracy should be followed—i. e., the accuracy of the control should not fall below the standard followed in running the interior lines, since the inaccuracies in control gauge the accuracy attainable in interior detail.

Where not enough funds are available to conduct a project in conformity with the survey and map requirements of standards 2 and 3 the district forester will select such methods, preferably in conformity with those prescribed in the Instructions for Making Topographic Surveys and Maps, as will give the most satisfactory results for the funds available. Funds from the special schedule for timber surveys will be used on such projects only with the approval of the Forester.

MAPPING.

The scale of maps in timber-survey projects will be no less than 4 inches to 1 mile.

The standard contour interval will be 50 feet. A departure from the standard will be permitted, in the discretion of the district forester, only when, because of choppy topography or for other reasons, a closer contour than 50 feet is necessary

to afford detailed map data required by the logging engineer in making an appraisal of the timber, or on long, steep slopes, where a greater interval than 50 feet will adequately depict the topography of the area and will in no way detract from the value of the map for appraisal or timber-sale administration purposes. In no case will a smaller interval than 25 feet or a greater interval than 100 feet be used.

Separate types and age classes and merchantable and unmerchantable timber areas of 10 acres or more in extent will invariably be mapped. Ordinarily, areas smaller than 2½ acres need not be mapped.

The symbols standardized for the Service will be used on timber-survey projects (see Instructions for Making Topographic Surveys and Maps). Where features to be included on timber-survey maps have not been standardized the district should use the symbols already employed by it or devise suitable ones. The extent to which symbols will be employed to indicate features of topography which affect logging transportation should be determined upon the advice of the logging engineer. The location of cliffs, ledges, rim rock, rock slides, patches of broken rock, or bed outcrops, swamps, marshes, flats, and benches has frequently been of material assistance to logging engineers in making an appraisal of the timber, and should be recorded uniformly on timber-survey maps.

The instructions in the Instructions for Making Topographic Surveys and Maps will be followed in monumenting stations and surveys on all permanent lines and in recording the monuments and descriptions.

ESTIMATING.

A record of the estimate will be kept upon Form 494 in accordance with the instructions outlined in the plan for the project.

Standard of Accuracy.

The standard of accuracy to be sought in estimates is 5 per cent plus or minus on areas over a section in extent, and 10 per cent plus or minus on areas of a section or less.

Percentage Traversed.

Except on areas best adapted to the use of the plot or 100 per cent estimate method (see "Method of traversing area") and in District 7, in which the district forester will prescribe the percentage of area to be covered (subject to the minimum requirements herein given), the standards to be followed in securing estimates of the timber on intensive projects are:

(1) Estimate the timber on 10 per cent of the ground containing commercially important species of merchantable size within the boundaries of probable sale areas.

(2) Estimate the timber on from $2\frac{1}{2}$ to 5 per cent of the areas containing timber not merchantable in size and timber of minor importance commercially.

(3) Traverse or plane-table burns, ridges, stands of young growth, and treeless areas to the extent necessary to obtain topographic data and type boundaries.

Estimating Unit.

The unit of estimating in surveyed country will be the 40; and in unsurveyed, the hypothetical square 40 or some other convenient unit not exceeding 160 acres selected by the chief of party in consultation with the supervisor and approved by the district forester. On the purchase areas on which the rectangular form of survey has not been used the unit of estimating for the project will be kept as small as practicable, so as to conform to the practice on lands surveyed rectangularly.

Method of Traversing Area.

The standard method of traversing areas will be by strips at least 1 chain in width on which the trees will be tallied by diameter breasthigh and unit of height to a given top diameter. The advantages of this method are its adaptability to both mapping and estimating practice, the opportunity given to systematize the courses run, and the probability that the areas traversed as a whole will represent average conditions on the tract. Scattered or isolated stands of comparatively small extent which can be more conveniently and accurately esti-

mated by the plot or 100 per cent estimate method may be so estimated, the use of the plot method being subject to the minimum standard requirements in percentage of area to be covered. With this exception, other methods than the strip method will be used only with the Forester's approval.

Diameters.

It is essential that great care be taken by the crews to secure the correct diameter breasthigh of trees on the area traversed. Ocular measurements of diameter should be made only by those proficient in judging diameter measurements. Even these should frequently check their judgment by actual measurements. The extent to which actual measurement will be done on each project will be determined by the district forester, subject to the minimum requirement that 25 per cent of all commercially important trees of merchantable size will be actually measured, preference being given to trees of the larger diameters.

Trees below merchantable size to a minimum diameter breasthigh of 6 inches may be recorded in such manner as the district forester may direct. Material under 6 inches diameter breasthigh will be classed as reproduction.

Heights.

In estimating volume by board measure the best method of determining heights is to estimate the number of logs of given length in each tree of merchantable size on the area traversed. the number of logs being rounded off to the nearest number of the given length. Another method, adapted to even-aged Douglas fir stands and stands of lodgepole pine and western white pine of uniform height, is to record the total height of each tree or the prevailing height of the timber in its relation to three or more height classes established for the project. In both instances the volume of the timber is obtained from volume tables, based in the first case upon diameter breasthigh and number of logs, and in the latter case on diameter breasthigh and total height. Heights should be taken in current work from time to time with

the cruiser's stick. These should be checked by occasional measurements made with a hypsometer or by pacing windfalls.

The method to be followed in determining heights of timber of merchantable size will be by the number of logs per tree, except under the following conditions:

(1) In even-aged stands of Douglas fir and in stands of lodgepole pine and western white pine of uniform height, to which existing height-class tables are believed applicable or for which applicable tables can be constructed readily, the alternative method given above may be employed in the discretion of the district forester, provided a distinct saving in cost can be effected thereby.

(2) When the material estimated is to be converted into special products, such as poles, ties, shingle bolts, etc., the estimate may be made on the basis of the appropriate market units.

(3) When volume is to be estimated in cubic feet an appropriate method of determining and recording heights will be prescribed by the district forester.

Quality of Timber.

Ultimately it is hoped that the quality of timber in the standing tree may be determined by and receive a log-grade classification. Therefore this practice should be adopted in timber surveys as rapidly as the crews develop capacity for it. It is followed to some extent in the Northwest at the present time on the basis of the standard specifications for logs in the general market. The classification of logs in standing trees in accordance with these specifications requires more experience than most members of timber-survey parties have had, so that for the present its general adoption is not considered practicable. When the designation of quality by log grade is for any reason impracticable, it will be the policy of the Service to express quality by clear bole or number of clear logs of stated minimum length and diameter, as provided by Form 494.

Volume Tables.

Arrangement will be made, as a part of the preparation of the project plan, to assemble volume tables for use by the crew, un-

less the district instructions already include suitable volume tables or the preparation of volume tables constitutes a part of the project. Every opportunity should be taken to test volume tables now in use, with a view to determining the extent to which they are applicable to timber in different parts of the district.

The most prolific sources of error in the application of volume tables, to which particular attention should be given in inspections, are:

(1) The use by the estimator of a different top diameter from that upon which the table is based.

(2) Differences between the top diameter upon which volume tables are based and those actually followed in logging.

(3) Differences between the form factor of the timber on which the volume tables were made up and that of the stand being estimated.

(4) Differences in thickness of bark.

Snags and Defect.

Form 494 provides for the number of snags of a given minimum diameter and height, the per cent of cull by species, and the extent of damage (expressed in per cent) by fire, insects, or other agencies. A record of the number of snags of sufficient size to constitute a fire menace is needed for use in prescribing fire-protective measures in timber-sale contracts. On projects which will be followed immediately by sales involving a tree-sanitation contract clause it will also be necessary, as an aid in appraisals, to have a record on the form of the number of unmerchantable diseased trees.

It is highly important that members of the crews be trained in determining defect in standing timber. With inexperienced crews doubtless it will be found advisable to use an average cull factor by species based upon the judgment of the chief of party and logging engineer and the per cent of defect found to exist on timber sale areas within the same region. Where individual species are very defective, a separate cull factor should be ascribed to them. Where individual trees are exceptionally de-

fective it is permissible to carry a special record of them in such a way as to indicate the percentage of defect, as by entering a percentage figure in a circle rather than the customary dot; thus entered in the appropriate blank on Form 494 would mean a tree 60 per cent defective.

Tallies.

Tallies will be kept separately by forties, logging units, and areas of merchantable and unmerchantable timber. Separate tallies for each type and age class may be required in the discretion of the district forester, except that a separate tally of scattering timber on areas which are mapped as unmerchantable will always be required. Where tallies are not changed for type and age class, all types and age classes traversed will be indicated on the back of Form 494, with the proportion of each.

Errors Likely to Occur in Estimating.

The errors most likely to occur in estimating are:

(1) Inaccuracy in estimating defect.
(2) Inaccuracy in the use of volume tables.
(3) Mistakes in measuring or guessing at diameters.
(4) Errors in determining heights.
(5) Failure to use the correct width of strip.
(6) Failure to include all and only trees actually within the strip.

Steps necessary to eliminate or reduce these errors to a minimum are outlined under "Field checks and inspection."

The practice of allowing for cull by reducing the diameter or height of individual trees will not be followed; nor, in determining the number by which to multiply the volume of a strip to get the volume of a forty, will the volume of the strip be increased or decreased to bring it to the estimator's general impression of the forty.

Correction Factors.

It should be understood that in broken stands, interspersed with parks, etc., the acreage on the strip and the acreage of timber on the forty or other unit are entirely distinct. The

latter is not any prescribed multiple of the former. The strip should stand by itself and its timber area and volume be computed as a basis for the determination of the total volume on the unit.

Where the strip represents more or less than the prescribed per cent of area in the forty, this will be allowed for mechanically by proportion, and the correct number used in multiplying the volume of the strip to secure the volume of the forty. The acreage of timber on the forty is divided by the acreage of timber on the strip, and the result multiplied by the volume on the strip to give the volume on the forty. For example, when the map for the forty shows 10 acres as grassland and 30 acres timber, and 8 chains of the strip were run through grassland and 12 chains through timber:

$$\text{Area of strip in timber} = 1.2 \text{ acres}$$

$$\frac{\text{Acreage of timber on forty}}{\text{Acreage of timber on strip}} = \frac{30}{1.2} = 25$$

Assuming that the volume on the strip is 15,000 feet, the volume of timber on the forty would be 375,000 feet.

Where tallies are kept separately by types and age classes and part of the forty is in one type or age class and part in another, the proper number by which to multiply the volume of each tally sheet is determined in the same way.

TYPES.

The "Standard classification of forest types" (see pp. 38 to 53) will be used in naming and recording types.

AGE CLASSES.

It is important that in designating and recording age classes the distinction between size, merchantability, and age be borne clearly in mind. The use of size as a constant indication of age will result in error in the case of small, scrubby, decadent, or subalpine stands. Size is given in the estimate, while special provision for mapping merchantability should be made by the

use of suitable symbols designating merchantable, in contrast to unmerchantable, stands. The simplest method of designating age classes is by the use of descriptive terms, clearly understood, which cover a range of age classes readily distinguishable, such as:

Overmature, over —— years old.
Mature, between —— and —— years old.
Intermediate, between —— and —— years old.
Poles, between —— and —— years old.
Saplings, between —— and —— years old.

SILVICAL DATA.

To be of value for subsequent use, silvical data must be so expressed as to permit their being assembled in comprehensive terms and mathematical form for the whole tract. Loose, general descriptions are useless. In order to simplify the collection of these data and permit their ready compilation, Form 494 provides for a statement of the condition of the timber, i. e., thrifty, mature, and decadent, in terms of percentage; and for a statement regarding reproduction in terms of density of stocking, i. e., no reproduction, one-third stocked, two-thirds stocked, and fully stocked. The form provides also for a statement of the proportion of the total reproduction on the area which the reproduction of each species represents. Ordinarily it will be necessary to report reproduction only in uneven-aged stands or where it constitutes the cover.

LOGGING FACTORS.

Observations on ground cover, ground surface, and topography should be made from the standpoint of their effect upon logging. Reproduction, so far as it is a factor in logging, should be considered in recording undergrowth. Form 494 provides for a brief statement on logging factors, under which is to be given the amount of undergrowth and windfall expressed in terms of

density, of bowlders and broken rocks expressed in terms of quantity, and such other factors as will indicate the ease or difficulty of the logging. To be of greatest value, notes secured on logging factors other than those specifically provided for on the form should conform to those desired by the logging engineer and incorporated in the project plan.

YIELD AND INCREMENT.

So far as practicable the data secured on timber-survey projects will be utilized in the construction of yield tables showing the actual yield of the watershed covered. Actual or empirical yields of the area in question may be secured from data on even-aged stands where the tallies are kept separate by type and age classes and in uneven-aged stands upon which the area of growth below merchantable size is determined.

In even-aged stands the tallies of each age class in each type are combined to give the average volume per acre of the age class. Each age class will thus give a point on a curve of yield for the area covered.

FIELD CHECKS AND INSPECTION.

Provision will be made in all project plans for specific field checks and inspection. Effective checks not only on the estimates, but on the maps and notes secured, are indispensable. These checks should be made during the progress of the work by the chief of party or a member of the party especially fitted for it, by the supervisor or his representative, and by members of the district office. Every man connected with timber surveys should understand that his work may be checked at any time.

It is the duty of the chief of party to have frequent check estimates made and to instruct members of the crews in all phases of their work. In order to insure that adequate attention is given to these important features of the project, each party chief should be required to make or have made a mechanical check estimate, with the original crew, on at least 3 per

cent of the strips covered, and to spend at least one-half day with each crew every 10 days for the purpose of instructing the men and checking up other phases of their work. The essential reason for the conduct of a mechanical check is to keep the accuracy of the estimates at a high standard by affording a thoroughly accurate basis for checking the work of the crews and pointing out to them the particular respects in which their estimates are in error. In order that the check estimate may serve this purpose, exact methods, such as chaining width of strip at frequent intervals, obtaining heights by hypsometer, etc., will be used as far as possible. The check estimate may be used also, as a basis for the correction of original estimates the accuracy of which is not within the standard prescribed, but its use for this purpose is considered incidental to its value for the maintenance of a high standard of accuracy by the crew.

In securing a check on the general efficiency of the crews particular attention will be given to the following points:

(1) That the vertical and horizontal ties at the ends of the strips are within the degrees of accuracy prescribed by the plan.

(2) That the crews are exercising the proper care in the width of strips within which the timber is tallied.

(3) That the crews understand and are securing satisfactory results in platting topography.

(4) That proper care is taken in the measurements of diameter and height.

(5) That proper allowance is made for defect.

(6) That the quality of timber is properly ascertained and recorded.

(7) That the acreage correction factor is correctly applied.

(8) That the volume tables in use are applicable.

(9) That the silvicultural condition of the timber is correctly interpreted and recorded.

(10) That there is full understanding and proper recording of the important logging factors.

(11) That notes required by the project plan and Form 494 are understood and properly entered.

Obviously, in the larger parties the chief of party must have assistance to follow the work of the crews so closely. Arrangement for this assistance can be made by the assignment of an assistant chief of party or by using for this purpose well-qualified members of the crew. Checks or inspection made by the supervisor or representatives of the district office will not in any degree lessen the obligation of the party chief to meet the requirements above prescribed. Such checks will supplement the minimum required of the party chief.

It is essential that early in the progress of the project a logging engineer or other highly qualified timber appraiser visit the party in order to give advice on all factors relating to the estimate and logging. He should conduct such checks as will satisfy him that the data required by the project plan as it relates to the estimate and logging factors are understood thoroughly and recorded properly. Further, a representative of the district office should visit the project during the field season and inspect the work from the standpoint of the sufficiency of silvicultural data secured.

An excellent method by which to control and direct the field work of the crews is to plat on the camp map the location of all interior lines run or to provide a skeleton map on which can be platted in colors by contrast the location and extent of areas covered by the crews.

PROGRESSIVE STEPS IN TIMBER-SURVEY PROJECTS.

In general, the progressive steps by which data are obtained for the completion of timber-survey projects are as follows:

MAP WORK.

(1) A control or camp map is begun by preliminary drafting work before field work begins. On this map are entered successively—

(*a*) Preliminary data from General Land Office surveys, United States Geological Survey triangulation or bench marks, and data from any other surveys available.

(*b*) Location of courses and points secured by the timber-survey crew for control, primary and secondary; General Land Office lines retraced, hypothetical section lines traversed, etc.

(*c*) Location and course of interior lines, covering all parts of the project.

This map is preserved as an important part of the permanent project record, and is of great value in subsequent administrative work.

(2) Field sketching plats are prepared by the crews, checked with one another as fast as completed, initialed by the men making them, and submitted to the party chief or draftsman.

(3) The project topographic map showing all topography, but no type, age class, area of merchantable and unmerchantable timber, or site-quality data, is compiled in camp by the party chief or draftsman as the work progresses. Current compilation permits checking any doubtful points while the party is on the ground. It is of special importance to have this map kept current with work on interior lines.

(4) A project type map (and, if desirable, site quality, age class, and merchantability area maps) is made up currently in camp, the types being shown by appropriate lines, colors, or symbols. Subsequently, maps showing these data in colors are produced on white prints from the tracing of the project topographic map.

ESTIMATES.

(1) If volume tables are not already available they are prepared from the detailed estimate data secured by the crews for use in computing volume.

(2) The timber on the areas traversed by the crews is tallied by diameter and number of logs, height class, and unit of product, or cubic-foot unit, as the case may be, for each forty or other area selected; the percentage of defect estimated; and the area of timber on the strip recorded. The area of timber on the forty is later computed from the map.

(3) From the above are computed:

(*a*) The gross and net volume of each species (or group of species) on the area traversed.

(*b*) The net volume of each species (or group of species) on the forty or other unit.

(*c*) The total net volume on the forty or other unit.

(4) The figures obtained by forties or other units under (3) are entered by species (or group of species) on summary sheets in order to secure a summary estimate by larger appropriate divisions, such as sections, townships, and logging units.

(5) Similarly, data are summarized by types, age classes, and merchantability area, by section, township, and logging unit, or by other appropriate larger divisions.

LOGGING AND SILVICAL DATA.

Notes are kept currently on Form 494 on the condition and quality of the timber, reproduction, and factors affecting logging. The major data under these heads are recorded by general descriptions, which lend themselves to convenient summarizing by forty, section, township, logging unit, or other division.

PROJECT REPORT.

It is the duty of the chief of party to bring into shape for presentation in working plan or report form all data collected in connection with the project. Upon him rests the responsibility of properly compiling the map and estimate data and coordinating the notes secured by the crews and by him independently on the condition and quality of the timber, logging factors, and other data relating to stumpage appraisals, and on such special problems as have arisen in connection with the project. Logging engineers and other representatives of the district office should add to the data compiled by the chief of party as much as they can and render him such assistance as he may need in the preparation of a complete report for the area. Unless the material which is to be included by the chief of party in the project

report and the form in which it should appear are prescribed in the district timber-survey instructions, the district forester will prescribe them for each project. This can be done best in outline form.

MAP AND ESTIMATE DATA.

So far as practicable all data will be compiled in the field as soon as possible after they are available; and if this is impracticable, compilation will be completed before the beginning of the following field season. This is necessary:

(1) To make data immediately available for use.

(2) To obtain the obvious benefits of compilation while the data are fresh in the minds of the men.

(3) To discover errors and omissions while there is the best opportunity for correcting them.

(4) To prevent the loss of important data through sudden changes in personnel.

(5) To prevent lost motion in ultimately formulating working plans.

In addition to reducing to a minimum the work of preparing the project report, the object should be to leave all data, notes, etc., in such form that a new man taking over the work will have the full benefit of what has already been done.

Topography, at least, should be transferred from the field sketches as fast as it is secured. Other map data, such as type and age class boundaries usually can be transferred to best advantage at the same time.

If final maps are to be prepared in the Office of Maps and Surveys at Washington, the field data, with necessary corrections, should be traced on tracing or linen paper, with topography and culture on one sheet and type lines, etc., on a second. From these tracings, the Office of Maps and Surveys will prepare photolithographic prints of any class of maps that falls within the standard printing list and photographic prints of other classes of maps needed. Each sheet may contain a township, logging unit, or other convenient unit, as desired.

If final maps are to be prepared in the district office, the district project plan should outline the particular method to be followed in camp compilation.

In all cases copies of final topographic base, type, age class, merchantability area, and estimate maps, singly or in combination as prepared, will be forwarded to the Washington office for the Forester's files.

Estimates should be computed in the field, if practicable, or as soon after the completion of the field work as possible. All important steps in computations must be carefully checked. If no cross checks on results are available, the computation must be made by two persons or twice by the same person.

Estimates may, in the discretion of the district forester, be tabulated, placed on separate copies of the topographic base (by putting them on separate tracings which can be superposed over the topographic base and printed in one operation), or placed on a plain sheet as a graphic table to be bound vis-à-vis to the topographic map.

For convenience in stumpage appraisal, estimates will be summarized by blocks and logging units and such other units or combination of units as may seem advisable. In surveyed country they will also be summarized by sections and townships. Where separate tallies are kept for each type and age class and the data is of advantage in stumpage appraisal the estimates should also be summarized by age classes within each type.

In order to put the estimate data to its highest use and to permit a later adjustment of it if any specific sale should make this necessary, the following summaries will be of value:

(1) The average number of logs per M feet board measure, for each species, worked out from volume computations.

(2) A summary estimate by log grades or other quality classes.

(3) The volume of inferior species in the smaller sizes or of commercial species in the smaller sizes where desirable, so that it may be eliminated, if necessary, in the consideration of prospective sales.

(4) The volume of all abnormally defective trees to which average cull factors are not applicable, so that it may be eliminated, if need be, in preparing an estimate for a prospective sale.

(5) Taper tables upon which a revision of the estimates may be made in case closer or poor utilization than that upon which the estimate was based is secured.

Further summaries by appropriate units, such as the number of trees by species and diameter classes, the average per cent of defect by species, and the number of snags and diseased trees may also be found desirable in localities where these factors are an important feature in appraisals and timber-sale administration.

DESCRIPTIVE DATA.

The descriptive portion of the report will cover all points essential to a complete understanding of the area from a silvicultural and logging standpoint which are not given on the maps or in the estimate tabulations. It should be brief and specific, presenting information in tabular form whenever possible. Photographs may often be used to good advantage. Since the immediate use to which the data are put will be for the promotion of timber sales, Form 578a will be found helpful for reference in its preparation.

The following outline for this portion of the report is suggested as covering the more essential points. If further factors are necessary for a complete understanding of conditions, they should be included.

1. Introduction.
   - *a.* History and personnel of the project.
   - *b.* General location of project.
   - *c.* Unit divisions.
2. Status and ownership.
3. Silvical description (compiled from Form 494).
   - *a.* Brief description of each type and age class, with the proportion and area of each.
   - *b.* The percentage of thrifty, mature, and decadent timber.

c. The percentage of timber killed or damaged by fire, insects, or other agency, with a statement of the nature of the damage.

d. The percentage of each degree of stocking, with reproduction; the occurrence, size, etc.

4. Logging data.

   A record compiled from Form 494 and including a brief descussion of the abundance of undergrowth, windfall, bowlders, broken rock, and other surface or topographic factors which have a direct bearing upon logging.

5. Recommendations for management.

   If desirable, the chief of party may be requested to submit recommendations concerning the future management of the area and the principles that should be followed in timber-sale administration in the event of a sale.

FORMS.

Form 878 (buff-colored paper), 878a (tracing linen), 878b (imitation vellum), and 878c (celluloid) have been adopted as standard for all classes of map work in connection with timber-survey projects, and Form 494 for recording the estimate and silvical and logging data. Aluminum Tatum holders of suitable size will be provided for use with these forms and may be had upon requisition of the property clerk. The use of other forms for mapping and recording estimates or for silvical and logging data will be permitted only with the Forester's approval. Each district may, however, adopt for camp use such additional forms, estimate summaries by logging units and townships, forms for requisitioning and invoicing supplies and equipment, and the like, as will simplify the compilation and camp duties of the party.

ADMINISTRATIVE REPORTS.

Brief reports at least monthly should be required, in order to keep the supervisor and district forester in touch with the work. It is not intended, however, that such reports shall supplant field inspection to any degree.

The data on timber surveys required for the annual statistical report (Form 446) will be submitted as heretofore.

The district forester will also submit at the end of each field season, and not later than February 1, a record of timber surveys during the preceding calendar year as outlined in the form on page 36 and a list of projects recommended for the ensuing fiscal year. He will also submit a statement showing the need for each project, its acreage, estimated cost, the character of map and estimate required, and the period necessary for its completion. Upon these lists the Forester will base tentative allotments from the special schedule for the guidance of the districts in submitting their detailed estimates.

RECORDS.

Simple plans for filing field data and correspondence in camp should be included in the district instructions or project plan. Upon the completion of the project all original data will be considered a permanent record and filed in the supervisor's office.

A record by major lines of work will be kept of the current costs on each project. This record will be in sufficient detail to permit an annual report to the Forester on Form 446 by fiscal years, and as herein outlined (see form on p. 36) by calendar years. Where the district keeps a more detailed record of costs than that called for by the form, a copy of the compiled district report will suffice.

Outline indicating data on completed timber-survey projects to be furnished the Forester by each district at the end of each field season (for the calendar year).

Forest.	Project.	Acres estimated.	Per cent of area covered.	Total cost of project.	Control.		Cost per acre.			
					Number of miles.	Cost per mile.	Control.	Topography.	Estimate.	Total.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
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.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	xxx	.....	xxx	.....	.....	xxx	xxx	xxx	xxx	xxx
Average.....	xxx	xxx	.....	xxx	xxx	.....	.....	.....	.....	.....

NOTE 1. The costs given should represent the total expenditures on the project. Compilation and other office work, and miscellaneous costs, such as supplies, ineffective days, moving, leave, travel to project, etc., should be charged directly to the activity concerned, i. e., Control, Topography, or Estimate, or prorated over them, as the case may be.

NOTE 2. Area, cost per acre, and total area to date for intensive and extensive timber surveys, by fiscal years, will be supplied on Form 446 as heretofore.

A systematic diagram map record of areas covered by intensive timber surveys will be maintained for the Forester's and district forester's files. These maps will be kept current annually, by Forests, and should contain the following information:

(1) All areas of one section or more in extent which have been covered by intensive timber surveys, whether conducted by special crews or by National Forest personnel. On each area should be entered the date when the work was done.

(2) All areas included in Forester's or district forester's sales, past and present. A number should be placed within each sale area and the designation of the sale entered under the same number on the margin of the map. In the case of con-

tracts canceled before completion a line should be drawn through the number designating the sale area in question. A subsequent sale covering the same area will then be designated by another number, or changes in the boundary of the new sale can be readily indicated without confusion.

(3) Areas cut over under sale contracts indicated by hatching the proper portion.

In order to secure uniformity the data shown on maps submitted to the Forester will be indicated in the following ways:

(1) Outline and hatch areas covered by timber surveys in green ink.

(2) Outline sale areas and number them in red ink; use black ink in striking out numbers to indicate cancellation of sales before completion.

(3) Indicate cut-over areas by hatching in red ink.

The diagram maps on file in the Forester's office will be returned each winter to the districts to be brought up to date.

EQUIPMENT.

Unless other arrangements are made by the district forester, all equipment should be secured through the supervisor, who will be responsible for having a sufficient quantity of suitable and necessary instruments and other equipment, forms, supplies, etc., on hand well before the project starts. The supervisor should have sufficient advance notice from the district forester after the preparation of the plan to permit his complying with this requirement. Foresight in this respect is necessary to avoid needless and costly delays after the crew is organized.

Each district should include in its district instructions a list of standard equipment for parties of a given size. For equipment required in conducting surveys see Instructions for Making Topographic Surveys and Maps. Criticisms of equipment should be forwarded to the Forester through the district forester, accompanied by suggestions for improvement.

STANDARD CLASSIFICATION OF FOREST TYPES.

(Revised February 1, 1917.)

The following standard classification of forest types will hereafter be the basis for all descriptive and mapping work in the National Forests, including grazing, as far as possible, without necessitating a departure from the approved type classification for grazing reconnaissance. It will be used in boundary, timber survey, timber sale, and general administrative work, and in all agricultural classification work except soil classification proper. Where further subdivision appears to be necessary in studies of yield or other investigations, approval of the new types proposed will be secured in advance.

The classification hereafter outlined is based upon the present composition of the stand, regardless of whether this composition is the ultimate cover of the site or merely a temporary cover resulting from some interference with natural conditions. Where a succession of types is known to occur, either the ultimate type or one of the stages in the succession which, as far as can now be foreseen, will be perpetuated in forest management, may, if desired, be mapped or used for purposes of management in addition to the present cover.

No attempt has been made to provide for all possible combinations of species, but a rather broad practical division has been used. Only such types as occupy sufficient area to be of importance in forest management have been included.

The name is taken wherever possible from the most distinctive commercial species or key tree occurring in the type, whether or not most of the stand is of this species.

The presence or absence of key trees or combinations of trees will often be found helpful in determining how to classify

any given stand. Keeping in mind the tree or trees which will be favored in cutting and the conditions which these trees require for successful growth will also assist the field men in distinguishing types.

The percentages given in the type descriptions are percentages of the number of the trees 8 inches and over in diameter, or of the trees which form the main stand and those which it is reasonable to suppose will eventually come up into the main stand. Thus, for example, in the Engelmann spruce type the young growth is often predominantly fir, alpine, or cork bark, most of which dies off before it becomes large enough to form part of the main stand. When, in a very mixed stand, the proportion of no one species comes up to the proportion named in the definition, the area will be thrown into the type which it most resembles, or the prevailing type in the immediate locality.

Burns, except for repeatedly burned areas which contain neither reproduction, grass, nor brush in appreciable quantities and are classified as barren, should not be classified as a distinct type. The presence of reproduction or burned timber, or both, is sufficient to make possible their mapping in accordance with the following classification. There is no objection, however, to indicating the area of the burn if desirable or necessary by a combination of the burn and type symbols.

The terms cover, temporary, permanent, and physical types are used with the following meaning:

A *cover type* is a forest type now occupying the ground. The term conveys no implication as to whether the type is temporary, or permanent, or one which we shall strive to maintain under forest management.

A *temporary type* is a forest type which has come in as a result of some interference with natural conditions, such as fire or lumbering, and which will eventually, if nature is left undisturbed, be replaced by a different type.

A *permanent type*, or *natural type*, also called ultimate or climax type, is a forest type which eventually will take possession of and perpetuate itself on any given area if natural conditions are undisturbed.

A *physical type* is understood to be an area considered with reference to its forest-producing power, as determined by the physical factors of the site. It refers to the land and not to the stand, although the stand, particularly in the case of permanent types, may be an excellent indication of the physical type, and is synonymous with "site" or "locality."

No standardization of physical types is being attempted at this time, since it is felt that further investigations are necessary to place such a classification on a sound basis. There is no objection, however, to the use by any district of such types, in addition to the forest type classification called for here, provided it is believed that such a classification is necessary, of practical value, and the data can be obtained without overloading timber survey crews.

DESCRIPTIONS OF TYPES.

TREELESS LAND.

There is no clear line of demarcation between trees and shrubs; and in this classification, which is purely for practical purposes, no attempt is made to draw a fine distinction between them. Accordingly, under "Treeless land" are included three types—"Brush," "Sagebrush," and "Chaparral"—which often are composed partly or entirely of individuals having tree form, but so small and stunted that the types in which they occur are classified ordinarily as treeless.

Barren. **All districts.**

An area too rocky, too exposed, too arid, or at too high an elevation to support trees or grass or more than a very scattering growth of herbs and shrubs; or an area so repeatedly burned that it contains neither reproduction, grass, nor brush in appreciable quantities.

Grass. **All districts.**

An area, such as a park, mountain meadow, or treeless ridge, whose principal vegetation is grass and other herbs.

Cultivated. **All districts.**

An area now under cultivation or lying fallow.

Chaparral. **District 5.**

An area too arid to support a nominal tree growth, but bearing a permanent cover of shrubs or stunted trees, occurring in southern California.

Sagebrush. **Districts 1, 2, 3, 4, 5, and 6.**

An area whose principal vegetation is sagebrush.

Brush. **All districts.**

All other areas the present cover of which is a stand of shrubs or stunted trees.

WOODLAND.

An area, usually at the lower altitudinal limits of tree growth, whose crop when mature is a stand of trees, ordinarily open, usually short, branchy, and crooked, most of which are fit only for cordwood, fencing, etc.

Piñon–Juniper. **Districts 2, 3, 4, and 5.**

A stand composed of approximately 80 per cent or more of piñon and juniper in varying proportions.

District 2.—Piñon (*Pinus edulis*), Rocky Mountain juniper (*Juniperus scopulorum*), and one-seed juniper (*J. monosperma*) are the chief species, often with some Gambel oak (*Quercus gambelii*) and western yellow pine.

District 3.—Piñon, Mexican piñon (*P. cembroides*), single-leaf piñon (*P. monophylla*), alligator juniper (*Juniperus pachyphloea*), one-seed juniper, Rocky Mountain juniper, and Utah juniper (*J. utahensis*) are the chief species, often with some Gambel oak and western yellow pine.

District 4.—Single-leaf piñon, Utah juniper, one-seed juniper, and Rocky Mountain juniper are the chief species, often with some Gambel oak and western yellow pine.

District 5.—Single-leaf piñon and Utah juniper are the chief species, often with some western juniper (*J. occidentalis*) and Jeffrey pine.

Juniper. **Districts 1, 5, and 6.**

A stand composed of approximately 80 per cent or more of any species of juniper, with very little or no pinon.

District 1.—Rocky Mountain juniper is the chief species, usually with some limber pine, western yellow pine, or Douglas fir.

District 5.—Western juniper is the chief species, often with some Jeffrey pine and western yellow pine.

District 6.—Western juniper is the chief species, often with mountain mahogany, and sometimes with a little western yellow pine.

Oak. **Districts 3, 4, 5, and 6.**

A stand composed of approximately 60 per cent or more of any species of western oaks.

District 3.—Emory oak (*Q. emoryi*), Arizona white oak (*Q. arizonica*), blue oak (*Q. oblongifolia*), and whiteleaf oak (*Q. hypoleuca*) are the chief species, often with some alligator juniper, Mexican piñon, and other species.

District 4.—Gambel oak is the chief species, and is usually pretty scrubby.

District 5.—California black oak (*Q. californica*), California rock oak (*Q. douglasii*), canyon live oak (*Q. chrysolepis*), California live oak (*Q. agrifolia*), highland oak (*Q. wislizeni*), California white oak (*Q. lobata*), and Garry oak (*Q. garryana*) are the chief species, often with some digger pine, madrone, and occasionally some knobcone pine, Coulter pine, Jeffrey pine, western yellow pine, and other species.

District 6.—Garry oak is the chief species, sometimes pure; more often it is mixed with California black oak, tanbark oak, madrone, myrtle, etc.

Digger Pine. **District 5.**

A stand containing approximately 40 per cent or more of digger pine, often mixed with various oaks, Coulter pine, western yellow pine, and other species. Occurs on any sites below the western yellow pine type.

TIMBERLAND.

An area whose crop when mature is a more or less dense stand of trees which may furnish sawlogs, ties, telegraph poles, etc.

Yellow Pine. **Districts 1, 2, 3, 4, 5, and 6.**

A stand containing approximately 50 per cent or more of western yellow pine, except where sugar pine is the key tree. Usually on dry well-drained sites at the lower altitudinal limit of timberland or exposed south and southwest slopes at higher altitudes.

District 1.—The principal species in mixture are Douglas fir, western larch, and lodgepole pine.

District 2.—The principal species in mixture are Douglas fir, white fir, blue spruce, and lodgepole pine.

District 3.—The principal species in mixture are Douglas fir and white fir, and rarely blue spruce.

District 4.—The principal species in mixture are Douglas fir, white fir, western larch, and lodgepole pine. An exception may be made in the case of distinct yellow-pine land containing less than 50 per cent of yellow pine, which may be mapped as yellow pine.

District 5.—The principal species in mixture are Jeffrey pine, incense cedar, sugar pine, Douglas fir, and white fir.

District 6.—The principal species in mixture are western larch, Douglas fir, white fir, grand fir, lodgepole pine, and sugar pine.

Jeffrey Pine. **District 5.**

A stand containing approximately 40 per cent or more of Jeffrey pine. Western yellow pine and white fir are often abundant, and there is usually some Coulter pine, incense cedar, or other species. At either low or high elevations, but almost invariably on the drier, less favorable and more exposed sites.

Sugar Pine–Yellow Pine. **Districts 5 and 6.**

A mixed stand in which sugar pine is the key tree forming approximately 15 per cent or more of the stand, and in which

yellow pine and incense cedar are its usual associates. Other species which occur in varying proportions are white fir, Douglas fir, bigtree, and Jeffrey pine. Such areas will be included in this type even though otherwise conforming to the definition of the yellow-pine type. Usually at moderate elevations and on favorable sites between the western yellow pine and fir types.

Sugar Pine–Fir. **District 5.**

Distinguished from the sugar pine-yellow pine type by the absence of yellow pine. Species in mixture are Douglas fir, white fir, and a very little incense cedar; at higher elevations, red fir. The type occurs chiefly in California north of the point where the Sierras lose their distinctive crest.

Western White Pine. **District 1.**

A stand in which western white pine is the key tree, forming approximately 15 per cent or more of the stand. In the northern part of the range of this type, at medium elevations, hemlock is the predominant tree, frequently outnumbering the white pine even in young stands; at higher elevations in the same region Engelmann spruce and alpine fir are the chief associates. In the middle of its range white pine occurs nearly pure or with Douglas fir as its chief associate, and with hemlock, white fir, larch, and sometimes lodgepole pine in mixture. In the southern part of the range of this type white pine is less important numerically than farther north. Here in young stands white pine occasionally forms as much as 50 per cent of the stand or more, but usually the predominant trees of the type are white fir and cedar, with Douglas fir and larch in mixture, a little yellow pine on the drier knolls, and sometimes in young stands lodgepole pine.

Lodgepole Pine. **Districts 1, 2, 4, 5, and 6.**

A stand containing approximately 50 per cent or more of lodgepole pine, usually nearly pure, but sometimes in mixture with other species.

District 1.—The principal species in mixture are Douglas fir, Engelmann spruce, alpine fir, and western larch.

District 2.—The principal species in mixture are Douglas fir, Engelmann spruce, alpine fir, blue spruce, bristlecone pine (*P. aristata*), and limber pine (*P. flexilis*).

District 4.—The principal species in mixture are Douglas fir, alpine fir, and Engelmann spruce.

District 5.—The principal species in mixture are white fir, red fir, and occasionally white pine. Stands with less than 50 per cent of lodgepole pine should be classed as the subalpine or fir type.

District 6.—The principal species in mixture are Douglas fir, alpine fir, yellow pine, grand or white fir, mountain hemlock, western larch, and silver fir. The type occurs along the ocean beach, on the pumice flats of the central Oregon Plateau, and at the higher elevations, as in the other districts.

Bristlecone Pine. **District 2.**

A stand containing approximately 60 per cent or more of bristlecone pine, often in mixture with limber pine, lodgepole pine, Engelmann spruce, blue spruce, Douglas fir, and white fir. Usually on dry, rocky, wind-swept sites at the higher elevations.

Douglas Fir. **Districts 1, 2, 3, 4, 5, and 6.**

A stand containing approximately 60 per cent or more of Douglas fir.

District 1.—The principal species in mixture are yellow pine, lodgepole pine, and western larch. Usually at the lower or medium altitudes, either at the lower limit of timberland or just above the yellow-pine type. Occurs also on north slopes above the white-pine type.

District 2.—The principal species in mixture are yellow pine, lodgepole pine, limber pine, white fir, and blue spruce. Usually at medium elevations and on poor or fairly favorable sites and moderately warm exposures.

District 3.—The principal species in mixture are yellow pine and white fir. Usually at medium altitudes between the yellow pine and Engelmann spruce types.

District 4.—The principal species in mixture are western yellow pine, lodgepole pine, and western larch. Usually at medium elevations between the yellow pine and lodgepole pine or Engelmann spruce types.

District 5.—The principal species in mixture are yellow pine, sugar pine, incense cedar, and white fir. Usually at medium elevations on fairly favorable sites. Nearly always on north and east slopes or moist bottoms.

District 6.—The characteristic forest west of the Cascades, occurring as pure stands of Douglas fir, or Douglas fir mixed with hemlock, cedar, and other species, such as Sitka spruce, Lawson cypress, grand fir, western white pine, silver fir, and rarely lodgepole pine.

Douglas Fir–Spruce. **District 4.**

A stand containing approximately 60 per cent or more of Douglas fir and Engelmann spruce in varying mixtures. Other species in mixture are western yellow pine, lodgepole pine, and western larch. Usually at medium elevations between the yellow pine and the lodgepole pine or Engelmann spruce types.

Cedar–White Fir. **District 1.**

A stand composed of cedar and white or grand fir, the former nearly pure in patches; the latter predominant throughout, with a considerable amount of Douglas fir, some yellow pine in groups on the knolls and as scattered individuals throughout, and rare western white pine individuals. The type occurs on the Selway National Forest and the southern portion of the Clearwater National Forest south of the commercial range of white pine.

Cedar–Hemlock–White Fir. **District 1.**

A stand composed of cedar, hemlock, and white or grand fir in varying proportions, with a little white pine, also Engelmann spruce, alpine fir, and rarely Douglas fir. Areas which

under management could be made to produce white pine in commercial quantities.

Larch–Douglas Fir. **Districts 1 and 4.**

A stand containing approximately 60 per cent or more of western larch and Douglas fir with white or grand fir in mixture. Larch is the key tree. The proportion of larch varies greatly, from very little to practically pure.

District 1.—The principal species in mixture is yellow pine, occasionally with lodgepeople pine, western white pine, lowland fir, western red cedar, or western hemlock. Usually at medium elevations, about the same as Douglas fir, but on more favorable sites. On less favorable sites than white pine.

District 4.—The principal species in mixture are yellow pine and lodgepole pine, white or grand fir, and Engelmann spruce. Usually at about the same elevation as the Douglas-fir type, but on slightly more favorable sites.

White Fir–Larch–Douglas Fir. **District 6.**

A stand containing approximately 60 per cent or more of western larch, white fir, grand fir, and Douglas fir, with some western yellow pine and lodgepole pine, but with yellow pine in the minority. Within its range western larch is the key tree. The proportion of each species varies greatly, from very little to practically pure. A prevalent type on the north and cool slopes within the yellow-pine zone; of secondary commercial importance and very variable mixture.

Western Hemlock. **District 6.**

A stand containing approximately 50 per cent or more of western hemlock, usually in mixture with one or more of the following: Douglas fir, western red cedar, grand fir, and silver fir. Found west of the Cascades on situations similar to those on which the Douglas fir type occurs; also on higher situations.

Cedar. **District 6.**

A mixed forest in which cedar is the important commercial species, usually comprising 40 per cent or more of the stand, the

associates being hemlock, grand fir, silver fir, Douglas fir, and sometimes a little Sitka spruce. It is found principally in valley bottoms on either side of the Cascades, but chiefly on the west side, contiguous to the Douglas fir or the western hemlock type.

Engelmann Spruce. **Districts 1, 2, 3, and 4.**

A stand containing approximately 50 per cent or more of Engelmann spruce. Sometimes follows a temporary type of aspen.

Districts 1, 2, and 4.—Engelmann spruce may be pure, but is more often in mixture with alpine fir, lodgepole pine, limber pine, Douglas fir, and occasionally, in District 2, bristlecone pine. Usually at the higher elevations and on the moister sites.

District 3.—Engelmann spruce may be pure, but is more often in mixture with alpine fir, Douglas fir, bristlecone pine, or cork-bark fir. At the higher elevations, usually at the upper limit of timberland.

Sitka Spruce. **District 6.**

A stand composed predominantly (usually at least 60 per cent) of Sitka spruce. It is found chiefly on valley bottoms and benches on the west side of the Olympic and Coast mountains.

Fir. **Districts 3, 4, 5, and 6.**

A stand containing approximately 50 per cent or more of one or more species of the true firs. White fir, alpine fir, red fir, Shasta fir, noble fir, and silver fir, either in combination or singly, usually predominate, with grand fir in smaller quantities.

District 3.—A stand containing 50 per cent or more of white fir. The chief tree in mixture is Douglas fir, associated with Engelmann spruce, alpine fir, and cork-bark fir at the higher elevations, and with yellow pine at the lower elevations.

District 4.—A stand containing approximately 60 per cent or more of white fir, alpine fir, or grand fir, either in combination or singly, with a varying mixture of Douglas fir, Engelmann spruce, and lodgepole pine. It is found at varying elevations,

depending on the exposure, within the Douglas fir and Engelmann spruce zones.

District 5.—A stand containing approximately 50 per cent or more of white fir, red fir, or Shasta fir; often in mixture with western white pine, sugar pine, mountain hemlock, and lodgepole pine, the last scattered or in pure patches; occasionally mixed with Jeffrey pine, incense cedar, and Douglas fir. At the higher elevations and on cool, moist sites.

District 6.—A stand characterized by noble, silver, Shasta, or red fir, either in mixture or singly. Other species in mixture are Douglas fir, western hemlock, mountain hemlock, western white pine, lodgepole pine, white fir, grand fir, western larch, and yellow cedar (*C. nootkatensis*). It is the characteristic type of certain situations on the upper slopes of the Cascades, usually above Douglas fir and hemlock types on the west and above the yellow pine and white fir-larch-Douglas fir types on the east of the Cascades. The key trees are silver fir and noble fir in the northern part and Shasta fir and red fir in the southern part of the district.

Red Fir. **District 5.**

A stand containing at least 75 per cent of red fir (*Abies magnifica*) or Shasta fir (*A. shastensis*), usually at the higher elevations below the subalpine type.

Mountain Hemlock. ***Districts 1 and 6.**

A stand containing approximately 50 per cent or more of mountain hemlock (*T. mertensiana*). Other species common in the mixture are alpine fir, silver fir, Shasta fir, alpine larch (*L. lyalli*), white-bark pine, lodgepole pine, western white pine, and Engelmann spruce. At the higher elevations usually near the upper limit of tree growth. Areas of mountain hemlock not capable of producing merchantable stands should be included in the subalpine type.

District 1.—The principal species in mixture are alpine fir, Engelmann spruce, and western white pine.

District 6.—The principal species in mixture are alpine fir, silver fir, lodgepole pine, alpine larch, and western white pine.

Subalpine. **Districts 1, 2, 3, 4, 5, and 6.**

A stand containing a varying mixture of subalpine species, no one of which is abundant enough to throw the stand into any of the types already described, or rarely pure stands. At the upper limit of tree growth, usually unmerchantable because of poor form and small size, and of value for protective purposes only.

District 1.—The principal species are alpine fir, Engelmann spruce, lodgepole pine, white-bark pine, limber pine, mountain hemlock, and alpine larch.

District 2.—The principal species are alpine fir, Engelmann spruce, lodgepole pine, limber pine, and bristle-cone pine.

District 3.—The principal species are Engelmann spruce, bristle-cone pine, limber pine, and dwarf juniper.

District 4.—The principal species are alpine fir, Engelmann spruce, lodgepole pine, white-bark pine, and limber pine.

District 5.—The principal species are red fir, Shasta fir, white fir, lodgepole pine, white-bark pine, western white pine, foxtail pine, and mountain hemlock.

District 6.—Usually characterized by alpine fir, but not necessarily containing a majority of this species: also has Shasta fir, noble fir, lodgepole pine, white-bark pine, western white pine, mountain hemlock, and alpine larch. It is a type which does not produce saw logs.

Redwood. **Districts 5 and 6.**

A stand containing approximately 80 per cent or more of redwood, usually with some Douglas fir, madrone, tanbark oak, and other smaller hardwoods. In situations at low elevations along the coast in California and southern Oregon.

Aspen. **Districts 2, 3, and 4.**

A stand containing approximately 60 per cent or more of aspen, often nearly pure, but sometimes with various conifers in mixture. At medium to high elevations, but usually on fairly

moist sites. Where desired and clearly practicable aspen stands may be mapped as young age classes of the type comprising the coniferous understory.

District 2.—The type may or may not have an understory of Engelmann spruce, alpine fir, Douglas fir, or yellow pine.

District 3.—The type has generally an understory of Engelmann spruce, cork-bark fir, and alpine fir, indicating an Engelmann spruce permanent type, or Douglas fir and white fir, indicating a Douglas fir or a fir permanent type.

District 4.—The type may or may not have an understory of Douglas fir, white fir, and Engelmann spruce.

Bottomland Hardwoods. **District 6.**

A stand consisting largely (usually 80 per cent or more) of any one or a mixture of the following species: Alder, black cottonwoods, broadleaf maple, Oregon ash. It is usually found on bottom lands or moist slopes at low elevations in western Oregon and Washington, where it is often a temporary type which is ultimately replaced by a coniferous forest.

Jack Pine. **District 2 (Lake States).**

A stand containing approximately 50 per cent or more of jack pine, occasionally mixed with Norway pine and often with a number of species of scrubby oaks. On the driest, sandiest soils.

Norway Pine. **District 2 (Lake States).**

A stand containing approximately 50 per cent or more of Norway pine, sometimes mixed with jack pine, white pine, hemlock, and several species of oak. On dry, sandy soils, slightly better than those characteristic of the jack-pine type.

White Pine. **District 2 (Lake States).**

A stand containing approximately 50 per cent or more of white pine, often mixed with Norway pine, hemlock, and a number of hardwood species. Usually on moderately moist, well-drained soil of better quality than that characteristic of the red-pine type.

Scrub Oak. **District 2 (Lake States).**

A stand containing a mixture of scrubby red, black, and scarlet oaks, with an occasional white oak, and some jack pine. Usually on sandy soil intermediate between that characteristic of the jack-pine and Norway-pine types.

Birch–Beech–Maple. **District 2 (Lake States).**

A stand composed chiefly of yellow birch, beech, sugar maple, and occasionally white elm, basswood, white oak, and conifers. On good or moderately good soils.

White Spruce. **District 2 (Lake States and Black Hills).**

A stand containing approximately 50 per cent or more of white spruce. In the Black Hills it is usually nearly pure, while in the Lake States it is usually mixed with balsam fir, arborvitæ, tamarack, and occasionally black spruce, and white pine. Usually on wet soils, but with good drainage.

Arborvitæ. **District 2 (Lake States).**

A stand containing approximately 80 per cent or more of arbor vitæ (*T. occidentalis*), sometimes mixed with tamarack or black spruce. Usually in shallow swamps on good soil without peat.

Tamarack–Spruce. **District 2 (Lake States).**

A stand containing approximately 80 per cent or more of tamarack or black spruce, either in combination or singly, occasionally with some arborvitæ or balsam fir. Usually in distinct swamps, often with some peat.

Longleaf Pine. **District 7.**

A stand containing approximately 80 per cent or more of longleaf pine, sometimes mixed with Cuban pine and with an undergrowth of turkey, blackjack, and live oaks. On the drier, sandier soils.

Titi. **District 7.**

Dense, junglelike swamps along the streams; composed of a great variety of species, all of which, except titi (*Cliftonia monophylla*), occur only scatteringly.

Shortleaf Pine. **District 7.**

A stand containing approximately 50 per cent or more of shortleaf pine, sometimes pure, but more often in mixture with various oaks and other hardwoods. Usually on the drier slopes.

White Oak. **District 7 (Arkansas).**

A stand composed chiefly of a varying mixture of white oak, red oak, post oak, black oak, hickory, black locust, black walnut, black gum, black cherry, beech, cottonwood, ash, willow, etc., and containing less than approximately 50 per cent of shortleaf pine. In nearly all situations, bottom, slope, and ridge. White oak is the key tree and predominates in most places.

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